

Australian Quantity Surveyors Utilize ICT and ERP System to Improve Efficiency

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Abstract

Despite Information Communication Technology (ICT) can help improve efficiency and Enterprise Resource Planning (ERP) system has been widely perceived as an efficient mean, diffusion rate is slow in construction industry and amongst quantity surveying profession. Today, quantity surveyor must frequently communicate with other stakeholder throughout the design and construction process and using information technology is a must. The more technologies evolve, the more quantity surveying with change and evolve to utilize these technologies. This paper, through literature review, firstly identifies perceived benefits of using ICT and ERP system; secondly concludes the critical success factors that may affect decision of adopting ICT/ERP tool in practice; and thirdly to suggest three effective evaluation tools before/after implementing ICT/ERP strategy. The ultimate goal is to advise how Australian quantity surveyors (QS) can utilize ICT and ERP system to improve efficiency.

Keywords

Quantity Surveying; Information Communication Technology; Enterprise Resource Planning System

Introduction

Although the construction industry is fourth contributors to the economy, it is considered to be one of the most highly fragmented, inefficient, and geographically dispersed industries (Cheng et al., 2001). Due to the specific characteristics of the construction industry, a complex communication environment is formed, often problems that are associated with construction have stemmed from communication problems. The quality of communication has a large influence on both the efficiency and effectiveness of the construction process (Hoezen et al., 2006). The Australian construction industry appears notorious for the slow uptake and implementation of ICT, this is despite numerous reported advantages from other on both a national and international level indicating that ICT can help improve efficiency (Jacobsson and Linderoth, 2012, Alaghbandrad et al., 2012, Peansupap and Walker, 2005b, Chan and Mills, 2011).

Two studies (Brewer and Gajendran, 2009, Anonymous, 2003) have been conducted to analyze the Australian construction industry's attitude towards ICT, and despite ERP system has been widely perceived as an efficient mean of ICT (Al-Mashari et al., 2003, Chan and Walker, 2006), there is no apparent evidence of the Australian construction industry implementing such a system. Obviously, the adoption rate of construction industry is slow. Quantity surveying, as one of the key professions, is also not up to the pace. This paper is about how Australian quantity surveyors can utilize ICT and ERP system to improve efficiency.

The focus of this paper is extensive literature review of ICT and ERP system and how these tools can help QS working more efficient. Firstly, the works by QS and rising trend to utilize communication tool when performing their works are discussed. The diffusion of ICT in Australia will then be analyzed and the use of ERP is explored. This follows by reviews of critical factors when implementing ICT and ERP strategy. This information will be gathered from a review of a range of sources on both ICT in the construction industry and ERP in general. Finally, evaluation methods are also discussed and given based on previous sections as to whether it is appropriate for Australian QS.

Problem Areas

ICT is often used as an extended synonym for information technology (IT). Boisot and Griffiths (2001) stated that IT greatly affects the flows of data within and across organizations. Following the convergence of computation and telecommunications, IT can greatly increase both data processing and communication processes, impacting both how knowledge is structured in an organization and how it is disseminated within and between organizations. Amongst those existing ICT tools, ERP system can be well used communication (Chan and Mills, 2011). According to Liaquant and others, ERPs are software

systems for business management encompassing modules supporting functional areas such as planning, manufacturing, sales, marketing, distribution, accounting, financial, human resource management, project management, inventory management, service and maintenance, transportation and e-business. The architecture of the software facilitates transparent integration of modules providing flow of information amongst all functions within the enterprise in a consistently visible manner (2002).

Before getting into the reasons of why ICT diffusion is slow, the following subsections study the QS work in general and the trend of using ICT.

Quantity Surveyor in Australia

Quantity Surveying has been part of the construction industry for over one hundred and seventy years (Cartlidge, 2011). Quantity surveyors may work for the supplier, specialist sub-contractor, contractor and client, their work and services is described as the financial management. They play an important role in the development of construction industry; they provide cost advice and administer the contract for a construction project from brief to final account stage is one of the key professions within the project team. A survey by the Royal Institute of Chartered Surveyors (RICS) in 1971 found that quantity surveyors viewed themselves primarily as the 'producers of bills of quantities', and that quantity surveying firms were discouraged from become multi-disciplinary practices (Cartlidge, 2011). The Australian Institute of Quantity Surveyors (AIQS) stages from the brief to the completion of the construction are clearly identified with their relationship to each other, and this AIQS framework has been staged sequentially in to the output to client, brief stage budget, outline proposal budget, sketch design cost plan, tender document cost plan and tender report (Smith and Jagger, 2006).

During these stages, the quantity surveyor can give cost and financial advice to the architect in order to obtain added value within the design solution. In turn, this enables the client and the design teams to generate an economic and feasible design solution, which may be analyzed to ensure that the client's requirements are satisfied (Burnside and Westcott, 1999). All of these new roles are directly related to the traditional quantity surveyor role of measuring quantities and estimating costs, however, they have now become integrated into the project team. In doing so, their knowledge and skills are fully utilized throughout the design process, by providing solutions to complex

problems on a broad scale. This relies on frequent communication with other stakeholders.

In fact, construction cost, construction management and construction communications are all key problem areas for a client who has desire to initiate a project, and quantity surveyors have the capability to manage construction cost and construction management. They must communicate effectively with a range of professional within construction industry. ICT is clearly one of those areas which have impact in different ways. It has clearly affected the way in which quantity surveyors have carried out their work. In some cases, this has removed some of the tedium, and speed up the processes that are used whilst in other spheres it has enabled quantity surveyors to both enhance and offer a wider range of services that their clients considers to be important. This applies not only to use computers for their work but also in terms of communication with the outside world through the electronic exchange of information amongst the team and the different professions involved. The more technologies evolve the more quantity surveying with change and evolve to utilize these technologies. This leads to another question about how ICT has been diffused and what types of tool can be used.

Australian ICT Diffusion and ERP Adoption

The followings are key recent research studies about diffusion of ICT tools and adoption of ERP system in Australian construction industry.

ICT Diffusion (Peansupap and Walker, 2005a)

Peansupap and Walker studied the diffusion of ICT within three main Australian construction contractors. The extensive discussion and implications section of this paper highlight the centrality of human relations. It is clear that people diffuse ICT innovation and they must feel motivated to do so. This introduces the importance of support mechanisms that include not only technical solutions such as superior hardware and software operational features, but also software support that is championed by supervisors who behave as role models. An important insight, uncovered by the research was the importance of an open discussion environment and organizational culture. This is important because it highlights the value of encouraging experimentation and learning from difficulties and mistakes, people feeling safe to ask for help and their colleagues being inclined to respond by helping. Fostering a supportive workplace environment is highlighted as an important lesson to

be learned for effective ICT Diffusion.

Opting the ERP Systems

Many organizations use ERP as the backbone of their ICT system. With the growing interest of many organizations in moving from functional to process-based IT infrastructure, ERP systems have become one of today's most widespread IT solutions. What motivate organization primarily to move to an ERP system is its integration and standardization capabilities, flexible client/server architecture (Al-Mashari, 2002). In fact, ERP is one facet of ICT that can be utilized to improve communication. ERP provides a general working environment for an enterprise to integrate its major business management functions with one single common database so that information can be shared and efficient communications can be achieved between management functions. (Shi and Halpin, 2003). The main characteristics have been indicated that an ERP system can be used well in the construction industry. However, there is no evidence of an Australian construction industry implementing such a system. While other industries that have embraced ICT such as automotive and banking have seen vast improvements in the electronic exchange of information and telecommunication (Love et al., 2001), yet the construction industry is still reported as being one of the most highly fragmented, inefficient, and geographically dispersed industries. In fact, a possible solution to the problem of communication can be resolved by the implementation of an ICT system such as ERP (Cheng et al., 2001).

Common IT Tool for QS

The rate of adoption of IT in the construction industry has been slow compared to most other industries despite its information intensive nature. The reasons for this slow adoption rate are many and varied (Smith, 2001), but there are some common IT tools for QS in Australia.

Buildsoft specializes in take-off software, construction estimating software, preparation of bill of quantities, electronic take-off as well as hard copy take-off through the use of digitizers. This software assists quantity surveyors professional to enhance their estimating skills by introducing them to innovative ways to speed up their take-off techniques whilst also saving them time and money in the preparation of the bill of quantities and throughout the estimating process.

CostX enables quantity surveyors to quickly and

accurately take off quantities from 2D drawings and generate automatic quantities from 3D BIM models using an on-screen electronic measurement system. From these measured quantities, they are then able to prepare estimates, bills of quantities and tenders easily in a time and cost effective process.

Leighton, one of the major contractors in Australia, commits to researching and developing in IT to ensure that the Group is well placed to capitalize on the latest developments in this sector. This was developed by Leighton and used by Leighton, Thiess and John Holland. This Computer Aided Tendering System (CATS) system can be used for estimating and tendering through every stage of the estimating process. This is a Windows-based version of the system which is a Leighton Group's use tailored, industry-specific technology.

From the commitment of Leighton, benefits of using IT are obvious and if ICT is one of the key components of IT family, in addition, the expected benefits are understandable.

Expected Benefits from ICT

Research study has found that despite its reluctant implementation, the motivation for investment in ICT by construction professionals is the following:

- Process efficiencies across geographically-dispersed teams and project partners.
- Improved internal communication and information flows
- Reduction in the cost of learning and knowledge acquisition
- Increased global competitiveness
- Enthusiasm to be at the forefront of technology development (Wong, 2007)

The second and third points made by the author mean the added benefits of ICT in communication. In fact, good communication among clients, architects, engineers, consultants, principals, and subcontractors is critical to achieve favorable outcomes in the construction industry. Cheng and others commented that due to the construction industry being so fragmented and represented by many different professions including architecture, structural, quantity surveying, civil, project management, subcontractors etc. problems can occur in communication lines. This can be from not having open lines of communication, inappropriate communication channels and unexpected communication breakdowns (Cheng et al., 2001). ICT

can then be used to improve many components of a construction company. This is achieved by aiding operational improvement through communication of construction information for effective decision-making and coordination as well as reducing the processing and communicating information time for making decisions (Peansupap and Walker, 2005a). When communication is supported by an effective ICT infrastructure, a competitive advantage can be gained (Chan and Mills, 2011). One of the obvious possible benefits in communication through the use of ICT is to give an organization the potential to gain business advantages through improved efficiency and whilst avoiding errors.

Methodology

Many companies nevertheless suffer from costly IT investment failures, one of the common reasons for these failures is the new ICT system's compatibility to the existing system, training, and technology mergers (Liu and Erickson, 2002). In order to tackle the problem and to enjoy the benefits, the method is to conduct research to determine critical factors leading to success and this can be done by relevant literature reviews.

In the literature review, an understanding of both the previous research and general writings that are relevant to your research area can be demonstrated. Secondly, different relevant previous research by others can be critically integrated and evaluated. This second point is important, because it can identify their key contribution to the field (Burton and Steane, 2004). Thus, a fruitful perspective of studying how Australian quantity surveyors can utilize ICT and ERP system to improve efficiency, a viable methodology is to review literatures. By means of a literature review, the paper seeks to provide a comprehensive perspective regarding factors that may facilitate the utilization of ICT and adoption of ERP System to improve AQS efficiently perform their duties.

Literature Reviews

This section summarizes two studies of using ICT in Australia, and research studies about the key factors affecting adoption of ERP system in developed countries. Finally, evaluation methods are suggested.

Two Relevant Studies

The first study conducted by Queensland University of Technology of professionals currently working in the construction industry found the following

significant observations from the survey:

- Generally, participants believed that a higher annual turnover was related to a higher ICT investment.
- Similarly, higher ICT investment generally meant a higher rate of access to emerging, innovative ICT solutions
- Participants believed that the number one reason for lack of ICT investment was financial concerns
- Incompatibility and the lack of an ICT professional on site were also found to be strong barriers on the take-up of ICT on projects
- Construction companies with lower turnovers were less supportive of ICT training and their staff were less likely to have undergone ICT training
- The biggest driver for ICT investment for respondents was to improve their organization's performance, specifically an improved productivity on both a personal and organizational level.
- The other notable reason for ICT investment was to gain business opportunities (Anonymous, 2003)

The second analysis is presented from a survey of Australian construction professionals conducted by the Australian Chartered Institute of Building in the evolving use of ICT Like many researchers (Brewer and Gajendran, 2009). The key points of the survey have been summarized and presented below:

- Subcontractors generally use ICT to automate their administration processes.
- Specialist subcontractors and consultants however rely on ICT primarily for fast exchange of communication with project teams.
- Some organizations find it hard to justify the time and money investment required to train their employees in ICT.
- Other barriers to effectively implement ICT are overcoming those who reject change internally, reaffirming the company's work culture and habits and setting up data exchange protocols with partners in various projects.
- Most construction projects do not use the full extent of available ICT systems. This is likely due to the incompatibility of the least capable project team member.

- Information security is a concern for many organizations, particularly in relation to data encryption, password protection and intellectual property rights whilst transferring documents through the ICT systems.
- Large players in the construction industry have the opportunity to influence business methodologies and demonstrate leadership. For example, some local government organizations are pioneering electronic tendering methods.
- Some organization successfully implementing ICT systems have difficulty and the same system suggested to project members who are only working together on a temporary basis.
- Although ICT has been identified as a technology that can assist in improving development of documentation, it is generally not utilized, largely due to contractual strictures and control of intellectual property.
- Due to the constantly changing nature of the industry and primary competitive tendering, only a select few utilize the use of ICT for communication with their stable supply chains.
- The respondents from the survey showed that the overarching issue is that of leadership and the role it has to play in driving the creation of ICT-enabled value and competitiveness.

The results from these two surveys of Australian construction industry participants show that whilst it is identified investment in ICT that can provide competitive advantage, and very few organizations use the technology to its full extent, potentially missing advantages in communication that can be translated to better client outcomes, better productivity and more business opportunities. Lam and others reflects this notion by suggesting that in ICT, development has outpaced the organizational readiness and adaptation in users' behavior (Lam et al., 2010). A whole commitment from the organization has become one of the critical success factors (CSF) but the temporary nature of projects in the construction industry with constantly shifting partners, each with their own individual objectives and working practices makes it difficult to achieve the ideal ICT configurations. The following three research studies show some of the key findings.

Critical Success Factors for ERP implementation in Chinese Construction Companies (Chan and Sin, 2010)

Since ERP is an information communication system that integrates a wide range of business operations, the DeLone and McLean's IS Model (DeLone and McLean, 2003) are used to analyze the success factors of ERP implementation. This model is a representative IS model which measures the success level of an IS implementation in an organization. Based on 180 empirical studies, they proposed system quality, information quality and service quality would affect intention to use as well as user satisfaction where the latter two would affect the net benefits to the organization and community at large. This model has been widely adapted to study the factors, leading to successful implementation of various information systems (Wang and Wang, 2009, Chatterjee et al., 2009, Teo et al., 2008, Huang et al., 2004). Therefore, it can be used as the model framework for the study.

The authors accomplished extensive literature reviews (Yusuf et al., 2006, Xue et al., 2005, Huang et al., 2004, Umble et al., 2003, Somers and Nelson, 2001, Martinsons and Hempel, 1995, Mandal and Gunasekaran, 2003, Law and Ngai, 2007, Hong and Kim, 2002, Holland and Light, 1999, Chou and Chang, 2008, Brown and Vessey, 1999, Bingi et al., 1999) to identify potential success factors for ERP implementation; then these major factors were concluded:

- Cultural differences
- Availability of helpdesk service from vendor / IT Department
- Need for process reengineering
- Price level
- Capability of customization
- Level of training to users
- Traceability of changes
- Availability of multiple languages

The survey result revealed that five variables are identified as important, including availability of helpdesk service from vendor and/or IT department, needed for process reengineering, price level, capability of customization and level of training to users.

Differences in Critical Success Factors in ERP Systems Implementation in Australia and China: A Cultural Analysis (Shanks et al., 2000)

It was attempted to identify differences in critical success factors in ERP systems implementation in Australia and China from the cultural perspective.

After an extensive literature reviews (Bancroft, 1996, Holland and Light, 1999, Parr et al., 1999), the eleven critical success factors synthesized from the literatures include:

- Top management support: the positive commitment, enthusiasm and support of senior management for the project
- External expertise: the use of the knowledge and experience of external consultants
- Balanced project team: a mix of IT and business people with broad understanding of business processes
- Data accuracy: data loaded from existing legacy systems must be of high quality
- Clear goals: the project must have clearly defined and well understood goals
- Project management: a detailed project plan related to the project goals should be defined
- Change management: careful attention must be given to change management, as the ERP implementation will involve changes to business processes
- Education and training: both technical knowledge about the ERP system and its reference models and knowledge about its operation and use for IT and business people
- Presence of a champion: an individual, not always a senior manager, who consistently advocates the benefits of the ERP system
- Minimal customization: minimizing the scope of the ERP system implementation and the amount of customization and option selection
- Best people full-time: project team members from within the organization need to be fully released from other duties during the ERP implementation project

The findings in this study should be of assistance to multinational organizations implementing ERP systems, international consultancy companies working with clients in different countries. Five common critical factors are identified: presence of a champion, change management, external expertise, project management and clear goals, data accuracy.

Evaluating the Critical Success Factors in ERP Implementation Using Fuzzy AHP Approach (Ansarinejad et al., 2011)

ERP is a high technical cross-functional information system to improve organizational performance and

competitiveness by streamlining business processes and eliminating duplication of work and data. Many studies have conducted to identify the critical success factors in the ERP implementation process, but most of them are lacking of systematic efforts to classify and evaluate. The authors have used a fuzzy group analytical hierarchy process (AHP).

This AHP is a hierarchical decomposing decision method for a complex multi-criteria decision problem (Saaty, 1980), and the process is extensively used for solving different multi-criteria decision making problems.

Based on literature review and experts' opinions (Walti, 1999, Wu and Wang, 2006, Xue et al., 2005, Wee, 2000, Ward et al., 2005, Van Everdingen et al., 2000, Umble et al., 2003, Sumner, 1999, Somers and Nelson, 2001, del Rosario, 2000, Roberts and Barrar, 1992, Panorama Consulting Group, 2008, Shanks, 2000, Parr et al., 1999, Ngai et al., 2008, Nah et al., 2001, Markus et al., 2000b, Markus et al., 2000a, Malhotra and Temponi, 2010, Kumar et al., 2002, King and Burgess, 2006, Holland and Light, 1999, Grabski and Leech, 2007, Gattiker and Goodhue, 2002, Gargeya and Brady, 2005, Falkowski et al., 1998, Ehie and Madsen, 2005, Davenport, 2000, Buckhout et al., 1999, Bingi et al., 1999, Al-Sehali, 2000, Al-Mashari and Al-Midimigh, 2003, Aladwani, 2001), fourteen factors among wide range of critical success factors are selected by the authors:

- Business Process and Software Customization: this can minimum customization and modification in software are the two important issues.
- ERP Vendor selection: this concerns maximum fitness and coordination of software with business processes, cost of license and flexibility of package or feasibility.
- Project Team: The project team members must have acceptable knowledge in the business processes and technical issues of the software.
- Project management/Business plan/Business model: To specify how the organization should operate behind the implementation effort there should be a clear business model.
- Project Scope: For all types of companies regarding to their size, the ability to maintain scope which is closely related to planning is very important.
- Implementation Method: Big method has higher risk but shorter implementation time than the phased method.

- **Management:** Top management should have sufficient commitment to allocate required and valuable resources to project.
- **Consultants:** Collaborating with consultants and using their experiences during all steps of implementation is considered.
- **Organizational/Communication:** Clear and regular communications among employees and project team members prevent implementation failure.
- **Readiness to Change:** Organizations should review the managers' and employees' readiness to change.
- **Training:** Re-skilling of IT employees could help to resolve the likely future problem.
- **Software Development:** Software and user interface development is in relation to change in software or interfaces to meet the organization and users' requirements include local languages.
- **Budgeting:** Most ERP implementations have spent more than expected, the ability to maintain planned budget is very central.
- **Testing and migration to new system:** Planning for the migration to new system and cleaning or modifying the old data after successful testing is important.

The results of this study show that "Managers and employees readiness to change", "Top management Support", "Business Process Reengineering", "Software and user interface development" and "Change management" are five top critical success factors.

Summary of CSFs from CSFs

From these various research studies reviewed, each top five CSF is summarized as below:

Chan and Sin (Chan and Sin, 2010)	Shanks and others (Shanks et al., 2000)	Ansarinejad and others (Ansarinejad et al., 2011)
Availability of helpdesk service from vendor and/or IT Department	Presence of a champion	Managers and employees readiness to change
Need for process reengineering	Change management	Top management Support
Price level	External expertise	Business Process Reengineering
Capability of customization	Project management and clear goals	Software and user interface development
Level of training to users	Data accuracy	Change management

The most common factors are capability of ICT tool i.e.

Capability of customization [refer to Chan and Sin(2010)], External expertise and User interface development [refer to Ansarinejad et al. (2011)], followed by process reengineering of the software i.e. Process reengineering [refer to Chan and Sin (2010)] and Business process reengineering [refer to Ansarinejad et al., (2011)] and attitude of top management i.e. Presence of a champion [refer to Shanks et al., (2000)], Top management support [refer to Ansarinejad et al., (2011)]. Change management [refer to Shanks et al., (2000) and Ansarinejad et al., (2011)] is another factor that must not be ignored.

For evaluation, key performance indicators are measurements designed to visualize, assess, and manage the performance of specific operations within organizations and can be used to evaluate the ICT and ERP strategy. As the IT strategy may not be identical for different companies, and this section suggests some viable evaluation tools so that each of them can select the appropriate tools.

DPWS - Effectively Use IT

The NSW Department of Public Works and Services (DPWS) is the largest construction client in Australia and, accordingly, has a significant influence on the future directions of the industry. Current DPWS strategies therefore provide a good example where the industry is heading. In 2000, Eden outlined the DPWS strategies to more effectively use IT to provide better value for money in capital works procurement. The aim is to achieve this by improving communication and teamwork through all phases of the design, construction and operation of facilities (Eden, 2000b); further described the following as the main directions necessary for the successful implementation of IT:

- Focus on project specific applications
- Integration of IT through the entire procurement and life cycle process and a feedback loop to the design and briefing stages
- Integration of IT through the entire supply chain including subcontractors and suppliers
- Recognizing the importance of and assisting in IT education and training of practitioners
- Use object-oriented project data-bases
- Sharing the learning experience between clients and industry, and
- Sharing the learning experience between the construction and other industries (Eden, 2000a)

AHP Approach (Huang et al., 2008)

A structural study of internal control for ERP system using the AHP approach to select key performance indicators of ERP systems have been conducted and the suggested evaluation include:

- Establishment of Information Technology (IT) organizations and their relations
- Integration and communication of financial information
- Development of IT strategic plans
- Management of information quality
- Monitoring of operating procedures

Pre-Adoption, During Adoption and Post-Adoption Analysis (Rankin and Luther, 2006)

This study analyzes the ICT adoption and state that there are challenges associated with ICT evaluation methods used in the construction industry. Each method involves a specific analytical technique. Depending on the technique used, the situation can be assessed on a project, company, or industry level. The times at which each analysis can be implemented; that is, analysis could be pre-adoption, during adoption, or post-adoption. The user cannot choose an evaluation tool that evaluates ICT investments on a particular level (e.g., company) at a specific time in the adoption cycle (e.g., pre-adoption). The analytical techniques are strictly defined and cannot be altered to meet the user's needs. The only option is to choose from the pre-specified tools and it is hoped that one fits. Because of the data required, the specific analytical technique used, and the specific technology evaluated, the various methods cannot be combined. Depending on the analytical technique, data collection can range from several weeks to several years, sample size can range from a single company to several hundred, and data can be collected from a variety of sources (owners, contractors, and so on). Specific analytical techniques yield specific results, with little room for interpretation. For example, a drawback of a net present value method is that flexibility (the ability to react to future trends) is difficult to quantify. A standardized method is necessary to evaluate the benefits of implementing ICT at various levels of the construction industry and various stages of adoption. In addition, they need a way to accurately predict the potential benefits of implementing a particular technology and then to evaluate the actual benefits after implementation. The method also has to be flexible so it can be adapted to various situations, such as different types of

companies, projects, and results.

- In light of these requirements, a standardized tool for decision making and ICT evaluation should provide a simplistic and user-friendly interface
- be usable in a reasonable amount of time
- be flexible and adaptable, to meet the user's needs
- provide accurate results
- be able to evaluate both direct and indirect benefits

Conclusion

This paper has discussed and investigated why and how QS can utilize ICT tool and ERP system to improve efficiency in construction industry. This has been completed through the use of extensive literature reviews and analyses.

This first part has identified the perceived benefits which include giving an organization potential to gain business advantages through improved efficiency and whilst avoiding errors.

This follows by the second part to conclude the CSF from CSF which are "Capability of Software", "Process reengineering", "attitude of Top management" and "Change management".

The third section of this paper has suggested three effective evaluation tools using the directives from DPWS, analytical tool of AHP and also adoption analyses before/after implementation of ICT tools and ERP system are required. All these will focus on the possible advantages from its implementation, so as to reap the benefits of IT.

Utilizing ICT tool is not a "zero sum game", all participants enjoy the benefits. Effective use ICT and working with ERP system lead to "real" success not merely because efficiency is improved. Using ICT and ERP can generate many tangible benefits: speedy communication, less error and abortive. Most importantly, there are many non-financial add-ons including savings in working hours for more time of family life and ongoing professional development for greater improvement.

REFERENCES

- Al-Mashari, M 2002, 'Enterprise resource planning (ERP) systems: A research agenda', Industrial Management and

- Data Systems, vol. 102, no. 3, pp. pp.165-70.
- Al-Mashari, M & Al-Midimigh, A 2003, 'ERP implementation: lessons from a case study', *Information Technology & People*, vol. 16, no. 1, pp. pp. 21-33.
- Al-Mashari, M, Al-Mudimigh, A & Zairi, M 2003, 'Enterprise resource planning: A taxonomy of critical factors', *European Journal of Operational Research*, vol. 142, no. 2, pp. p.352-64.
- Al-Sehali, SH 2000, 'The factors that affect the implementation of enterprise resource planning (ERP) in the international Arab Gulf states and United States companies with special emphasis on SAP software.', Doctoral Dissertation thesis, University of Northern Iowa
- Aladwani, AM 2001, 'Change management strategies for successful ERP implementation', *Business Process Management Journal*, vol. 7, no. 3, pp. pp. 266-75.
- Alaghbandrad, A, Asnaashari, E & Preece, C 2012, 'Problems and barriers of ICT utilization on Iranian construction sites: Case study on the successful use of ICT in remote construction sites', *Journal of Information Technology in Construction*, vol. 17, no. Special Issue, pp. pg. 93-102.
- Anonymous 2003, A Case in Point Investigation of ICT Uptake, Queensland University of Technology.
- Ansarinejad, A, Amalnick, M-S, Ghadamyari, M, Ansarinejad, S & Hatami-Shirkouhi, L 2011, 'Evaluating the Critical Success Factors in ERP Implementation Using Fuzzy AHP Approach', *International Journal of Academic Research*, vol. 3, no. 1, pp. 65-80.
- Bancroft, N 1996, *Implementing SAP/R3: how to introduce a large system into a large organisation*, Manning / Prentice Hall, London, UK.
- Bingi, P, Sharma, M & Godia, J 1999, 'Critical issues affecting an ERP implementation', *Information Systems Management*, vol. 16, no. 3, pp. pp. 7-14.
- Boisot, M & Griffiths, D 2001, 'To Own or to Possess? Competence and the Challenge of Appropriability', in R Sanchez (ed.), *Knowledge Management and Organizational Competence*, Oxford Press, Oxford, pp. p.210-26.
- Brewer, G & Gajendran, T 2009, 'Emerging ICT trends in construction project teams: a Delphi survey', *Journal of Information Technology in Construction*, vol. 14,, no. Special Issue in Technology Strategies for Collaborative Working, pp. pp. 81-97.
- Brown, C & Vessey, I 1999, 'ERP Implementation Approaches: Toward a Contingency Framework', paper presented to ICIS 1999 Proceedings.
- Buckhout, S, Frey, E & Nemec, JJ 1999, 'Making ERP succeed: turning fear into promise', *IEEE Engineering Management Review*, vol. 19, pp. pp.116-23.
- Burnside, K & Westcott, T 1999, 'Market trends and developments in QS services', paper presented to Construction, Building and Real Estate Research Conference The University of Salford, UK, , , September 1-2, 1999.
- Burton, S & Steane, P 2004, *Surviving Your Thesis*, Routledge, London,.
- Cartlidge, D 2011, *New Aspects of Quantity Surveying Practice*, Spon Press, Hoboken.
- Chan, CTW & Sin, HC 2010, 'Critical success factors for ERP implementation in Chinese construction companies', in *Industrial Informatics (INDIN)*, 2010 8th IEEE International Conference on, pp. 628-33.
- Chan, E & Mills, A 2011, 'Implementation of enterprise resource planning (ERP) software in a major construction contracting organization in Hong Kong', *International Journal of Managing Projects in Business*, vol. 4, no. 1, pp. pp.168 - 78.
- Chan, WLE & Walker, DHT 2006, 'Using a Knowledge Management Evaluation Framework for Improving an ERP system - A Hong Kong Construction Industry Case Study.', in *Knowledge Management Asia Pacific Conference 2006*, Hong Kong.
- Chatterjee, S, Chakraborty, S, Sarker, S, Sarker, S & Lau, FY 2009, 'Examining the success factors for mobile work in healthcare: A deductive study', *Decision Support Systems*, vol. 46, no. 3, pp. 620-33.
- Cheng, EWL, Li, H, Love, PED & Irani, Z 2001, 'Network communication in the construction industry', *Corporate Communications: An International Journal*, vol. 6, no. 2, pp. pp.61 - 70.
- Chou, SW & Chang, YC 2008, 'The implementation factors that influence the ERP (enterprise resource planning) benefits', *Decision Support Systems*, vol. 46, no. 1, pp. 149-57.

- Davenport, T 2000, *Mission critical : realizing the promise of enterprise systems*, Harvard Business School Press, Boston, MA.
- del Rosario, JG 2000, 'On the leading edge: critical success factors in ERP implementation projects', *Business World*.
- DeLone, WH & McLean, ER 2003, 'TheDeLone and McLean Model of Information Systems Success: A Ten-Year Update', *Journal of Management Information Systems*, vol. 19, no. 4, pp. 9-30.
- Eden, J 2000a, 'Government Leadership - Directions, Actions and Timeframes for NSW Construction Authorities and the Australian Procurement and Construction Council', paper presented to Construction IT 2000 Conference, Sydney, April.
- Eden, J 2000b, 'Information Technology in Construction - Making IT Happen', *Australian Civil Engineering Transactions*, vol. Vol. 42, pp. pp. 71-5.
- Ehie, IC & Madsen, M 2005, 'Identifying critical issues in enterprise resource planning (ERP) implementation', *Computers in Industry*, vol. 56, no. 6, pp. 545-57.
- Falkowski, G, Pedigo, P, Smith, B & Swanson, D 1998, 'A recipe for ERP success', *Beyond Computing*, no. September, pp. pp. 44-5.
- Gargeya, VB & Brady, C 2005, 'Success and failure factors of adopting SAP in ERP system implementation', *Business Process Management Journal*, vol. 11, no. 5, pp. pp. 501-16.
- Gattiker, TF & Goodhue, DL 2002, 'Software-driven changes to business processes: An empirical study of impacts of Enterprise Resource Planning (ERP) systems at the local level', *International Journal of Production Research*, vol. 40, no. 18, pp. 4799-814.
- Grabski, SV & Leech, SA 2007, 'Complementary controls and ERP implementation success', *International Journal of Accounting Information Systems*, vol. 8, no. 1, pp. 17-39.
- Hoezen, MEL, Reymen, IMMJ & Dewulf, GPMR 2006, 'The problem of communication in construction', in UoT Eindhoven (ed.), *International Conference on Adaptable Building Structures*, Eindhoven, Netherlands, pp. pp.12-9.
- Holland, CP & Light, B 1999, 'A critical success factors model for ERP implementation', *IEEE Software*, vol. 16, no. 3, pp. pp. 30-6.
- Hong, K-K & Kim, Y-G 2002, 'The critical success factors for ERP implementation: an organizational fit perspective', *Information & Management*, vol. 40, no. 1, pp. 25-40.
- Huang, S-M, Chang, IC, Li, S-H & Lin, M-T 2004, 'Assessing risk in ERP projects: identify and prioritize the factors', *Industrial Management & Data Systems*, vol. 104, no. 8, pp. pp. 681-8.
- Huang, SM, Hsieh, PG, Tsao, HH & Hsu, PY 2008, 'A structural study of internal control for ERP system environments: a perspective from the Sarbanes-Oxley Act', *International Journal of Management and Enterprise Development*, vol. 5, no. 1, pp. pp. 102-21.
- Jacobsson, M & Linderöth, HCJ 2012, 'User perceptions of ICT impacts in Swedish construction companies: 'it's fine, just as it is'', *Construction Management & Economics*, vol. 30, no. 5, pp. 339-57.
- King, SF & Burgess, TF 2006, 'Beyond critical success factors: A dynamic model of enterprise system innovation', *International Journal of Information Management*, vol. 26, no. 1, pp. 59-69.
- Kumar, V, Maheshwari, B & Kumar, U 2002, 'Enterprise resource planning systems adoption process: A survey of Canadian organizations', *International Journal of Production Research*, vol. 40, no. 3, pp. 509-23.
- Lam, PTI, Wong, FWH & Tse, KTC 2010, 'Effectiveness of ICT for Construction Information Exchange among Multidisciplinary Project Teams', *Journal of Computing in Civil Engineering*, vol. 24, no. 4, pp. 365-76.
- Law, CCH & Ngai, EWT 2007, 'ERP systems adoption: An exploratory study of the organizational factors and impacts of ERP success', *Information & Management*, vol. 44, no. 4, pp. 418-32.
- Liaquant, H, Jon, DP & Rashid, MA 2002, *Enterprise Resource Planning: Global Opportunities and Challenges*, Enterprise Resource Planning Solutions and Management, IRM Press, Hershey.
- Liu, LY & Erickson, C 2002, 'Engineering and Construction Collaboration Using Information Technology', in First International Conference on construction in the 21th Century, Miami, Florida, USA, pp. p.521-8.
- Love, P, Irani, Z, Li, H, Cheng, EW & Tse, R 2001, 'An empirical analysis of the barriers to implementing e-commerce in small-medium sized construction contractors in the state of Victoria, Australia', *Construction Innovation: Information, Process*,

- Management, vol. 1, no. 1, pp. pp.31-41.
- Malhotra, R &Temponi, C 2010, 'Critical decisions for ERP integration: Small business issues', *International Journal of Information Management*, vol. 30, no. 1, pp. 28-37.
- Mandal, P &Gunasekaran, A 2003, 'Issues in implementing ERP: A case study', *European Journal of Operational Research*, vol. 146, no. 2, p. 274.
- Markus, ML, Axline, S, Petrie, D & Tanis, SC 2000, 'Learning from adopters' experiences with ERP: problems encountered and success achieved', *Journal of Information Technology (Routledge, Ltd.)*, vol. 15, no. 4, pp. 245-65.
- Markus, ML, Cornelis, T & Paul, CvF 2000, 'Enterprise resource planning: multisite ERP implementations', *Communications of the ACM*, vol. 43, no. 4, pp. 42-6.
- Martinsons, M &Hempel, P 1995, 'Chinese management systems: historical and cross-cultural perspectives', *Journal of Management Systems*, vol. 7, no. 11, pp. pp.1-11.
- Nah, FF-H, Lau, JL-S &Kuang, J 2001, 'Critical Factors for Successful Implentation of Enterprise System', *Business Process Management Journal*, vol. 7, no. 3, pp. pp. 285-96.
- Ngai, EWT, Law, CCH &Wat, FKT 2008, 'Examining the critical success factors in the adoption of enterprise resource planning', *Computers in Industry*, vol. 59, no. 6, pp. 548-64.
- Panorama Consulting Group 2008, '2008 ERP REPORT Retrieved from <http://www.panorama consulting.com/>'.
- Parr, AN, Shanks, GG &Darke, P 1999, 'Identification of Necessary Factors for Successful Implementation of ERP Systems', paper presented to Proceedings of the IFIP TC8 WG8.2 International Working Conference on New Information Technologies in Organizational Processes: Field Studies and Theoretical Reflections on the Future of Work.
- Peansupap, V & Walker, DHT 2005, 'Factors Affecting ICT Diffusion: A Case Study of Three Large Australian Construction Contractors', *Engineering Construction and Architectural Management*, vol. 12, no. 1, pp. 21-37.
- Peansupap, V & Walker, DHT 2005, 'Factors enabling information and communication technology diffusion and actual implementation in construction organisations', *Electronic Journal of Information Technology in Construction*, vol. 10, pp. pp.193-218.
- Rankin, JH & Luther, R 2006, 'The innovation process: adoption of information and communication technology for the construction industry', *Canadian Journal of Civil Engineering*, vol. 33, no. 12, pp. 1538-46.
- Roberts, HJ &Barrar, PRN 1992, 'MRPII implementation: key factors for success', *Computer Integrated Manufacturing Systems*, vol. 5, no. 1, pp. 31-8.
- Saaty, T 1980, *The analytic hierarchy process: planning, priority setting, resource allocation*, McGraw-Hill International Book Co., New York ; London.
- Shanks, G 2000, 'A model of ERP project implementation', *Journal of Information Technology (Routledge, Ltd.)*, vol. 15, no. 4, pp. 289-303.
- Shanks, G, Parr, A, Hu, B, Corbitt, B, Thanasankit, T &P.Seddon, P 2000, 'Differences in Critical Success Factors in ERP Systems Implementation in Australia and China: A Cultural Analysis', in *European Conference on Information Systems*, Vienna, Austria p. Paper 53.
- Shi, JJ &Halpin, DW 2003, 'Enterprise Resource Planning for Construction Business Management', *Journal of Construction Engineering & Management*, vol. 129, no. 2, p. 214.
- Smith, J &Jaggar, D 2006, *Building Cost Planning for the Design Team*, Taylor & Francis, Burlington.
- Smith, P 2001, 'Information Technology and the QS Practice', *Australasian Journal of Construction Economics and Building*, vol. Vol 1, no. 1, pp. pp. 1-21.
- Somers, TM & Nelson, K 2001, 'The impact of critical success factors across the stages of enterprise resource planning implementations', in *System Sciences, 2001. Proceedings of the 34th Annual Hawaii International Conference on*, p. 10 pp.
- Sumner, M 1999, 'Critical success factors in enterprise wide information management systems projects', paper presented to Proceedings of the 1999 ACM SIGCPR conference on Computer personnel research, New Orleans, Louisiana, United States.
- Teo, TSH, Srivastava, SC & Jiang, LI 2008, 'Trust and Electronic Government Success: An Empirical Study', *Journal of Management Information Systems*, vol. 25, no. 3, pp. 99-131.
- Umble, EJ, Haft, RR &Umble, MM 2003, 'Enterprise resource planning: Implementation procedures and critical success factors', *European Journal of Operational Research*, vol. 146, no. 2, pp. pp. 241-57.

- Van Everdingen, Y, Van Hillegersberg, J & Waarts, E 2000, 'Enterprise resource planning: ERP adoption by European midsize companies', *Communications of the ACM*, vol. 43, no. 4, pp. 27-31.
- Wang, W-T & Wang, C-C 2009, 'An empirical study of instructor adoption of web-based learning systems', *Computers & Education*, vol. 53, no. 3, pp. 761-74.
- Ward, J, Hemingway, C & Daniel, E 2005, 'A framework for addressing the organisational issues of enterprise systems implementation', *The Journal of Strategic Information Systems*, vol. 14, no. 2, pp. 97-119.
- Wee, S 2000, 'Juggling toward ERP success: keep key success factors high', *ERP News*, 2000, February, available <http://www.erpnews.com>.
- Welti, N 1999, *Successful Sap R/3 Implementation: Practical Management of ERP Projects*, Addison-Wesley.
- Wong, CH 2007, 'ICT implementation and evolution: Case studies of intranets and extranets in UK construction enterprises', *Construction Innovation: Information, Process, Management*, vol. 7, no. 3, pp. 254 - 73.
- Wu, JH & Wang, YM 2006, 'Measuring ERP success: the ultimate users view', *International Journal of Operations & Production Management*, vol. 26, no. 8, pp. 882-903.
- Xue, Y, Liang, H, Boulton, WR & Snyder, CA 2005, 'ERP implementation failures in China: Case studies with implications for ERP vendors', *International Journal of Production Economics*, vol. 97, no. 3, pp. 279-95.
- Yusuf, Y, Gunasekaran, A & Wu, C 2006, 'Implementation of enterprise resource planning in China', *Technovation*, vol. 26, no. 12, pp. 1324-36.